Play, Learn, Teach: Digital Game-Based Learning Perceptions and Practices of Pre-Service Science Teachers

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Abstract. This study aimed to investigate digital game-based science learning perceptions and practices of pre-service science teachers. Using simple random sampling, data were collected from 70 out of 84 fourth-year Bachelor of Secondary Education Science students, and the descriptive correlation results were determined using descriptive statistics. The factors examined included technological proficiency, self-efficacy, game-based learning skills, and digital resources. The results indicated that the participants generally perceived themselves as proficient in various technological aspects, with notable strengths in basic digital communication skills. While the participants felt confident in integrating digital game-based learning, there were identified challenges in creating educational games and receiving formal training. Despite financial and technological limitations, pre-service teachers exhibited a proactive approach to overcoming these perceptions, particularly through peer mentoring, team teaching, and self-initiative. The study found a strong positive correlation between perceptions and practices, highlighting the interconnected nature of these factors in the effective implementation of digital game-based learning. The researchers proposed an action plan to enhance their practices.

Keywords: digital, peer mentoring, resources, self-efficacy, technology

1 Introduction

Digital game-based, when integrated into education, has the potential to revolutionize the learning experience. It could create an engaging and interactive environment that fosters collaboration and provides new avenues for teaching and learning. It plays a crucial role in developing the essential 21st century skills that are highly valued in today's digital economy [1].

In today's society, science plays a vital role in providing Innovative knowledge, advanced technologies, and effective solutions to address global issues. However, many

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students in the Philippines have a strong aversion to the subject of science, as it is often considered as a difficult subject. This is evident in the 2018 PISA result; the Philippines ranked second to last in science and mathematics, and it was reaffirmed in the 2022 PISA results. According to the OECD PISA 2022 Database, the Philippines ranked third from the bottom in science with an average score of 356. This result showed the need for effective teaching strategies to address the perceptions in science education in the Philippines. The low performance in science literacy requires an upgrade of existing instructional methods and an exploration of innovative approaches that are more in line with the demands of the 21st century.

In the context of 21st-century education, where the development of critical thinking, problem-solving skills, and digital literacy is crucial, utilizing digital game-based learning has emerged as a promising pedagogical approach. One of the factors that affect science learning in secondary students is teaching approaches. Game-based learning is a method of obtaining new concepts and skills through the use of digital and non-digital games. Game-based learning integrates educational content with interactive and immersive gameplay, providing students with a more enjoyable and interactive learning experience [2,3].

The Republic Act No. 10533, also known as the Enhanced Basic Education Act of 2013, aimed to enhance the country's basic education system by implementing the K-12 program. This act declares the state to establish, maintain, and support a complete and integrated system of education that is relevant to the needs of the people. It encourages innovative and learner-centered approaches, which include game-based learning. In addition, the Department of Education in partnership with Microsoft Philippines engaged students, teachers, and parents in an immersed learning experience through the Minecraft Education Edition: DepEd Active Citizen Campaign. The MEE is designed to encourage the use of game-based learning with easy-to-use lesson plans, worlds, and resources to create richer classroom experiences [4,15].

Many studies have shown that game-based learning can enhance students' motivation, engagement, and understanding of scientific concepts, since most research assesses the effectiveness and perceptions of pre-service teachers in the integration of digital game-based learning, the researchers sought to investigate the perceptions and perceptions in utilizing digital game-based learning pedagogy in science lessons. Conducting research on this topic can help in enhancing teacher preparation, ensuring equitable access, promoting innovative teaching methods, and ultimately improving student outcomes. Thus, this study wanted to document if there is a significant relationship between the perceptions and practices of pre-service teachers in the utilization of digital game-based in science. In addition, it is to fill those gaps and contribute to the existing body of knowledge [5,6,7].

2 Methodology

2.1 Research Design

This study used the descriptive correlational research design to determine the extent of perceptions by Pre-service science teachers and their practices in utilizing digital game-

based science lessons. The researchers apply descriptive research design in order to answer the problems being imposed in this study. A descriptive-correlational research design does not need to establish a causal connection among variables for its main focus is to describe and measure their relationship.

2.2 Participants of the Study

The table 1 shows the participants of this study were the 4th year pre-service science teachers of Caraga State University. The researchers made a questionnaire that was validated by three (3) experts in their respective fields. Any areas that were found defective were corrected. To establish the reliability of the instrument, 30 copies of survey questionnaires were administered to the randomly selected 3rd Year BSED Science students of Caraga State University, In the subsequent discussion, the expert used a continuous scale for a five-choice answer.

Table 1. Participants of the Study

School assigned	**No. of pre-service science teachers**	**Sample of pre-service science teachers**
Taligaman National High School	22	16
Butuan City School of Arts & Trades Taguibo Main Campus	30	25
AVISS-ANNEX	12	10
Butuan City School of Arts & Trades Taguibo ANNEX	7	7
Libertad National High School	5	4
Ampayon National High School Buenavista SPED High School	5 2	4 1
Pedro Duncano National High School	1	1
Total	**N = 84**	**n = 70**

To guarantee the accuracy and reliability of the research instrument, the researchers conducted a reliability test. Cronbach's alpha, ranging between 0 and 1, measures the internal consistency of survey items believed to measure the same construct and thus are correlated, forming a scale. Higher alpha values indicate greater reliability, with 0.70 often cited as the threshold for confidence in scale reliability, though some suggest

0.75 or 0.80. If alpha is ≤ 0.70, modifying the scale is recommended. In this study, the scales demonstrated high internal consistency: "Technological Proficiency" (α = 0.936), "Self-Efficacy" (α = 0.971), "Game-Based Skills" (α = 0.928), "Digital Resources" (α = 0.941), "Peer Mentoring" (α = 0.977), "Team Teaching" (α = 0.985), and "Self-Initiative" (α = 0.965). These high values suggest that the items consistently measure their respective underlying constructs.

3 Results and Discussion

3.1 Pre-service Science Teachers' Perceptions in Technological Proficiency

Table 2. Extent of Perceptions in Technological Proficiency

Items	Mean	SD	Verbal Description	Verbal Interpretation
TP 1	4.10	0.71	Agree	High
TP 2	4.20	0.69	Agree	High
TP 3	4.21	0.76	Agree	High
TP 4	3.86	0.84	Agree	High
TP 5	4.31	0.79	Strongly Agree	Very High
TP 6	4.11	0.81	Agree	High
TP 7	3.74	0.93	Agree	High
TP 8	4.29	0.80	Strongly Agree	Very High
TP 9	4.31	0.73	Strongly Agree	Very High
TP 10	4.49	0.72	Strongly Agree	Very High
Overall	4.16		Agree	High

Mean: 4.23-5.00-Strongly Agree, 3.43-4.22-Agree, 2.62-3.42-Neutral, 1.81-2.61-Disagree, 1.00-1.80-Strongly Disagree

The data in table 2 demonstrates that there was a generally high level of digital literacy perceptions among the participants. The majority were familiar with basic digital communication tools and felt confident in their ability to use them. The findings of this study were supported by the study who discussed that preservice teachers who are digital natives perceived themselves as competent with educational technology, as they were familiar with it from an early age [8,28].

This indicated that most of the participants gave similar responses in the statement. The table above showed that the participants generally agreed that they were proficient in various technological aspects, with a grand mean score of 4.16, which can be interpreted as a high level of perceptions in technological proficiency. This data indicated that the majority of the preservice teachers perceived themselves as competent with technology [24].

3.2 Pre-service Science Teachers' Perceptions in Self-Efficacy

Table 3. Extent of Perceptions in Self-Efficacy

Items	Mean	SD	Verbal Description	Verbal Interpretation
SE 1	4.03	0.80	Agree	High
SE 2	3.71	0.87	Agree	High
SE 3	3.94	0.81	Agree	High
SE 4	3.83	0.78	Agree	High
SE 5	3.84	0.77	Agree	High
SE 6	3.97	0.85	Agree	High
SE 7	3.90	0.71	Agree	High
SE 8	3.89	0.84	Agree	High
SE 9	3.99	0.79	Agree	High
SE 10	3.77	0.95	Agree	High
Overall	3.89		Agree	High

Mean: 4.23-5.00-Strongly Agree, 3.43-4.22-Agree, 2.62-3.42-Neutral, 1.81-2.61-Disagree, 1.00-1.80-Strongly Disagree

As presented in table 3, the grand mean score for self-efficacy was 3.89, indicating that the participants generally felt confident in their ability to integrate digital game-based learning into their teaching practices. The results of this study showed that pre-service teachers are confident in utilizing digital game-based learning (DGBL) activities, but they face challenges in creating these activities [9,10]. Preservice teachers exhibit confidence in using DGBL in their classrooms; however, they often struggle with the creation of these activities. The study also highlighted that while these future educators are enthusiastic about integrating digital games into their teaching practices, they require more comprehensive training to develop the necessary skills for designing effective DGBL activities. This indicates a need for enhanced training programs that focus on practical skills and provide hands-on experience in creating digital game-based learning tools [11,12].

To effectively incorporate digital games into their teaching practices, teachers need to have a clear vision of teaching and learning. Understand how digital games can enhance student engagement and learning outcomes. Additionally, having a positive attitude towards the subject of digital games is crucial. This positive mindset allows teachers to embrace the potential of digital games as educational tools and be open to exploring innovative teaching methods [13,14]. Teachers need to possess technical-pedagogical capabilities related to digital games. This includes being familiar with different digital game platforms and understanding how to use them effectively in the classroom. They should also be able to navigate the pre-game, in-game, and post-game stages of incorporating digital games into their teaching. This involves planning and preparing game-based interventions, guiding students during gameplay, and evaluating the learning outcomes after the game. To ensure that teachers are well-equipped to teach with games, it is important for pre-service teachers to undergo the appropriate training processes [15].

3.3 Pre-service Science Teachers' in Game-based Skills

Table 4. Extent of Perceptions in Game-Based Skills

Items	Mean	SD	Verbal Description	Verbal Interpretation
GBS1	4.09	0.81	Agree	High
GBS 2	4.09	0.86	Agree	High
GBS 3	3.96	0.88	Agree	High
GBS 4	4.00	0.87	Agree	High
GBS 5	3.36	1.13	Neutral	Moderate
GBS 6	3.70	0.95	Agree	High
GBS 7	4.10	0.82	Agree	High
GBS 8	3.77	0.92	Agree	High
GBS 9	3.87	0.88	Agree	High
GBS 10	4.07	0.84	Agree	High
Overall	3.90		Agree	High

Mean: 4.23-5.00-Strongly Agree, 3.43-4.22-Agree, 2.62-3.42-Neutral, 1.81-2.61-Disagree, 1.00-1.80-Strongly Disagree

The table 4 illustrates that the participants agreed that they were exposed to digital game-based learning, with a grand mean score of 3.90, which can be interpreted as a high level of perceptions in game-based skills. Among the tasks of universities, teacher training is undoubtedly one of the most important. The educational methodology that supports games' integration is based on the theoretical framework called Technological Pedagogical and Content Knowledge (TPACK). This framework refers to the dynamic association between three categories of knowledge: (a) content, (b) pedagogy and (c) technology and suggests that educational technology requires teachers' professional development and training [16, 19].

Teachers' training plays a crucial role in promoting the integration of technology in the classroom and cultivating a positive attitude towards its use. The primary objective of this training is to equip educators with the necessary skills and competencies to effectively utilize digital tools in the learning process. A study conducted further emphasizes the benefits of Digital Game-Based Learning (DGBL) in teacher training. It highlighted how DGBL can significantly enhance teachers' abilities and proficiency in utilizing technology, thereby improving their overall teaching practices. [The study also highlighted the positive impact of DGBL on both in-service and pre-service teachers, underscoring the need for comprehensive training and ongoing support to empower educators in embracing technology as a valuable educational resource. Comprehensive training initiatives that provide hands-on experience, practical guidance, and ongoing support can empower teachers to confidently incorporate technology into their teaching methodologies. Ultimately, this will not only enhance their own skills and competencies but also contribute to the overall advancement of the education system, preparing students for the digital age and equipping them with the necessary skills for their future success [17,18].

3.4 Pre-service Science Teachers' in Digital Resources

Table 5. Extent of Perceptions in Digital Resources

Items	Mean	SD	Verbal Description	Verbal Interpretation
DR 1	3.96	0.86	Agree	High
DR 2	3.66	0.95	Agree	High
DR 3	3.81	0.82	Agree	High
DR 4	3.30	1.01	Neutral	Moderate
DR 5	3.26	1.10	Neutral	Moderate
DR 6	3.47	0.94	Agree	High
DR 7	3.80	0.86	Agree	High
DR 8	3.69	0.84	Agree	High
Overall	3.65		Agree	High

Mean: 4.23-5.00-Strongly Agree, 3.43-4.22-Agree, 2.62-3.42-Neutral, 1.81-2.61-Disagree, 1.00-1.80-Strongly Disagree

In table 5, the grand mean score for the digital resources was 3.65, which can be interpreted as a high level of perceptions in digital resources. Suggesting that participants generally agreed that they had access to necessary resources. Based on the findings, most participants have the required electronic devices at their disposal. There are some who face challenges due to outdated technology, suggesting financial and technological limitations. Overall, participants tend to agree that they have access to the necessary resources. The differences in average scores and standard deviations highlight the influence of financial and technological constraints on their ability to fully maximize these resources [19,20].

3.5 Pre-service Science Teachers' Practices in Peer entoring

Table 6. Extent of Practices in Peer mentoring

Items	Mean	SD	Verbal Description	Verbal Interpretation
PM 1	3.97	0.90	Agree	High
PM 2	3.99	0.83	Agree	High
PM 3	4.09	0.83	Agree	High
PM 4	4.03	0.87	Agree	High
PM 5	4.01	0.84	Agree	High
PM 6	4.00	0.82	Agree	High
PM 7	4.01	0.89	Agree	High
PM 8	3.97	0.85	Agree	High
PM 9	3.96	0.86	Agree	High
PM 10	4.01	0.81	Agree	High
Overall	4.00		Agree	High

Mean: 4.23-5.00-Strongly Agree, 3.43-4.22-Agree, 2.62-3.42-Neutral, 1.81-2.61-Disagree, 1.00-1.80-Strongly Disagree

The results showed in table 6 that the grand mean is 4.00, indicating a high overall score. This means that the educators' practices in digital game-based learning prioritize peer collaboration, guidance, and continuous improvement. These practices have been found to enhance teaching practices and student engagement. Moreover, the positive attitudes towards seeking help, receiving feedback, and focusing on learning outcomes contribute to a supportive environment. This environment fosters professional growth and innovation in educational approaches [30]. In conclusion, these findings demonstrate the effectiveness of these practices in promoting effective teaching and learning in digital game-based education.

3.6 Pre-service Science Teachers' Practices in Team Teaching

Table 7. Extent of Practices in Team Teaching

Items	Mean	SD	Verbal Description	Verbal Interpretation
TT 1	4.27	0.74	Strongly Agree	Very High
TT 2	4.21	0.76	Agree	High
TT 3	4.24	0.73	Strongly Agree	Very High
TT 4	4.17	0.85	Agree	High
TT 5	4.09	0.79	Agree	High
TT 6	4.19	0.82	Agree	High
TT 7	4.11	0.79	Agree	High
TT 8	4.20	0.77	Agree	High
TT 9	4.20	0.81	Agree	High
TT 10	4.14	0.86	Agree	High
Overall	4.18		Agree	High

Mean: 4.23-5.00-Strongly Agree, 3.43-4.22-Agree, 2.62-3.42-Neutral, 1.81-2.61-Disagree, 1.00-1.80-Strongly Disagree

The table 7 presented that the team teaching is highly valued by educators, as reflected in the grand mean score of 4.18, indicating a general agreement with the benefits and effectiveness of collaborative teaching approaches. The positive attitudes towards team teaching in digital game-based learning highlight its significance in facilitating teamwork, expertise sharing, organization, idea sharing, classroom management, student engagement, and overall success in science education [29]. By adopting collaborative teaching approaches that incorporate digital games, educators can harness valuable opportunities to improve teaching methods, enhance student learning, and create a dynamic and engaging educational atmosphere [16,21]. These approaches allow students to actively participate in the learning process, collaborate with their peers, and develop critical thinking skills while exploring scientific concepts through interactive and immersive game-based activities. Additionally, team teaching in digital game-based learning provides a platform for educators to leverage their expertise collectively, share best practices, and create a supportive and collaborative environment that fosters student success and academic achievement. Overall, the integration of digital games into collaborative teaching approaches offers a promising avenue for transforming science education and enhancing the overall learning experience for students [22,23].

3.7 Pre-service Science Teachers' Practices in Self-Initiative

Table 8. Extent of Practices in Self-Initiative

Items	Mean	SD	Verbal Description	Verbal Interpretation
SI 1	3.89	0.86	Agree	High
SI 2	3.86	0.80	Agree	High
SI 3	3.93	0.84	Agree	High
SI 4	3.94	0.90	Agree	High
SI 5	3.79	0.85	Agree	High
SI 6	3.80	0.88	Agree	High
SI 7	3.97	0.91	Agree	High
SI 8	3.89	0.85	Agree	High
SI 9	3.94	0.86	Agree	High
SI 10	3.94	0.88	Agree	High
Overall	3.88		Agree	High

Mean: 4.23-5.00-Strongly Agree, 3.43-4.22-Agree, 2.62-3.42-Neutral, 1.81-2.61-Disagree, 1.00-1.80-Strongly Disagree

Table 8 revealed the extent of practices in self-initiative. Based on the study self-initiative plays a crucial role in educators' engagement with digital game-based learning, as evidenced by the grand mean score of 3.88, indicating a general agreement with statements related to proactive learning and professional development. Educators' self-initiative in digital game-based learning encompasses a proactive approach towards resource exploration, integration, modification, collaboration, and professional development. Their willingness to explore new strategies, engage in continuous learning, and actively contribute to the advancement of digital game-based teaching practices contributes to the overall positive perception of self-directed learning and innovation in educational settings [17,24].

3.8 Correlation between Pre-Service Science Teachers' Perceptions and Practices of Game-Based Learning

Table 9. Relationship Between the Perceptions and Practices of the Pre-Service Science Teachers

Variables		Correlation Coefficients	p-values	Remarks
Perceptions	Practices	0.679_R	0.00	Significant

R - Spearman's rho coefficient; r – Pearson correlation coefficient

The study found a significant relationship between the extent of perceptions and the practices of pre-service teachers, with a Spearman's rho correlation coefficient of 0.679 as shown in table 9. This indicates a strong positive correlation, suggesting that as the extent of perceptions increases, the use of practices also increases. The rejection of the null hypothesis confirms that pre-service teachers actively employ practices in response

to the perceptions they face in utilizing digital game-based learning. This finding highlights the adaptive nature of pre-service teachers in overcoming barriers through various supportive and self-initiated measures. They may seek help from peers and mentors, participate in professional development opportunities, experiment with different digital tools, and adjust their instructional methods to better integrate game-based learning into their teaching practice. By doing so, they demonstrate resilience and a proactive approach to improving their educational techniques in the face of technological and pedagogical perceptions [25,26].

Studies support the notion that pre-service teachers actively employ practices when faced with perceptions in utilizing digital game-based learning (DGBL). Pre-service teachers deal with difficulties in integrating DGBL into their teaching. The study found that these teachers often use a combination of problem-focused and emotion-focused practices [28]. Problem-focused strategies include seeking additional resources, collaborating with peers, and engaging in continuous professional development. Emotion-focused strategies involve maintaining a positive attitude and using self-reflection to manage stress and anxiety related to the integration of new technologies. This dual approach enables pre-service teachers to effectively navigate the complexities of DGBL, ensuring a more seamless incorporation of digital games into their educational practice. A similar study highlighted that pre-service teachers develop a range of practices to address difficulties in integrating DGBL. These strategies include enhancing their technological skills, seeking collaborative opportunities, and adapting instructional methods [27, 31].

As the extent of perceptions increases, the use of practices also intensifies. This relationship suggests that pre-service teachers become more resourceful and resilient when faced with greater difficulties. They are likely to employ a wider range of strategies and invest more effort into overcoming obstacles, thereby enhancing their capability to integrate DGBL successfully.

4 Conclusion

The research on Investigating Digital Game-Based Science Pedagogy examined pre-service teachers' perceptions and practices, revealing strong digital skills but lower confidence in self-efficacy and creating digital activities. It highlighted gaps in formal DGBL training and resource availability, emphasizing the need for better training and resources to enhance DGBL integration in science education. Based on the findings of the study on the perceptions and practices of pre-service teachers in utilizing digital game-based learning in science lessons, the following recommendations are proposed: Schools should invest in up-to-date equipment and provide access to high-quality digital games and tools to improve infrastructure and offer subsidies for essential resources, helping teachers better integrate DGBL into their teaching. Targeted workshops and hands-on training sessions should be implemented to enhance teachers' skills and confidence in developing digital game-based activities. Comprehensive professional development programs focusing on practical strategies and continuous support are needed to effectively implement game-based learning. Establishing formal peer

mentoring programs can encourage collaboration and the exchange of best practices, helping pre-service teachers feel more supported and capable. Future researchers are encouraged to foster a culture of research and innovation in digital game-based education, leading to further advancements and qualities.

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